

# Solubility of Hydrocarbons in Physical Solvents

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## ABSTRACT

This paper compares the solubility of hydrocarbons in several physical solvents such as ethylene glycol, diethylene glycol, triethylene glycol, methanol, and dimethyl ethers of polyethylene glycol (DEPG, a solvent marketed by Union Carbide, UOP, and Coastal). Most of these solvents are designed to extract unwanted components such as water and acid gases. However, these solvents also have a tendency to remove the hydrocarbon product. Quantifying this amount of absorption is critical in order to minimize hydrocarbon losses or to optimize hydrocarbon recovery depending on the objective of the process. The influence of several parameters on hydrocarbon solubility including temperature, pressure and solvent water content is examined. Suggested operating parameters to achieve hydrocarbon absorption objectives are included. Hydrocarbon solubility is a major factor when considering the use of a physical solvent.

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## INTRODUCTION

Physical solvents are used to treat natural gas streams in a number of ways. Glycols such as ethylene glycol (EG), diethylene glycol (DEG), triethylene glycol (TEG) and methanol are commonly used in wet gas dehydration processes. EG and methanol are also injected into wet gas to act as hydrate inhibitors. Acid gas removal can be accomplished by the physical solvent DEPG, which is a mixture of dimethyl ethers of polyethylene glycols, and by methanol. Physical solvents such as DEPG can also be used to absorb hydrocarbons to meet a hydrocarbon dew point in a process similar to the lean oil absorption process [1]. The dehydration qualities of DEPG allow for dehydration in conjunction with hydrocarbon removal.

Physical solvents all absorb hydrocarbons to some extent. In most cases the hydrocarbon removal is undesirable, and should be minimized. In other cases such as the DEPG ITR process which includes hydrocarbon recovery [1], the pickup should be maximized or at least optimized. Both temperature and pressure affect hydrocarbon absorption. In general, the lower the temperature and the higher the pressure, the more hydrocarbons will be dissolved in the physical solvent. In some cases, however, the hydrocarbon solubility actually increases with temperature [2]. Solvent water content also affects hydrocarbon pickup. The higher the water content, the less the hydrocarbon absorption [3, 4]. This characteristic also aids in separating the solvent from the hydrocarbon [5].

Equilibrium data and in some cases operating data is available for hydrocarbon solubility in most of the physical solvents. In this paper, the process simulator PROSIM<sup>®</sup> [6] will be demonstrated to match the experimental solubility data very closely and to be used to investigate factors affecting hydrocarbon solubility in physical solvents.

### ***Ethylene Glycol***

GPA RR-117 [7], RR-149 [8], RR-137 [9] contain equilibrium data for solubility of methane, propane, n-heptane,

methylcyclohexane, and toluene in EG. Hydrocarbon solubility as predicted by PROSIM is compared to selected equilibrium data in Table 1.

**Table 1**  
**Hydrocarbon Solubility in EG**

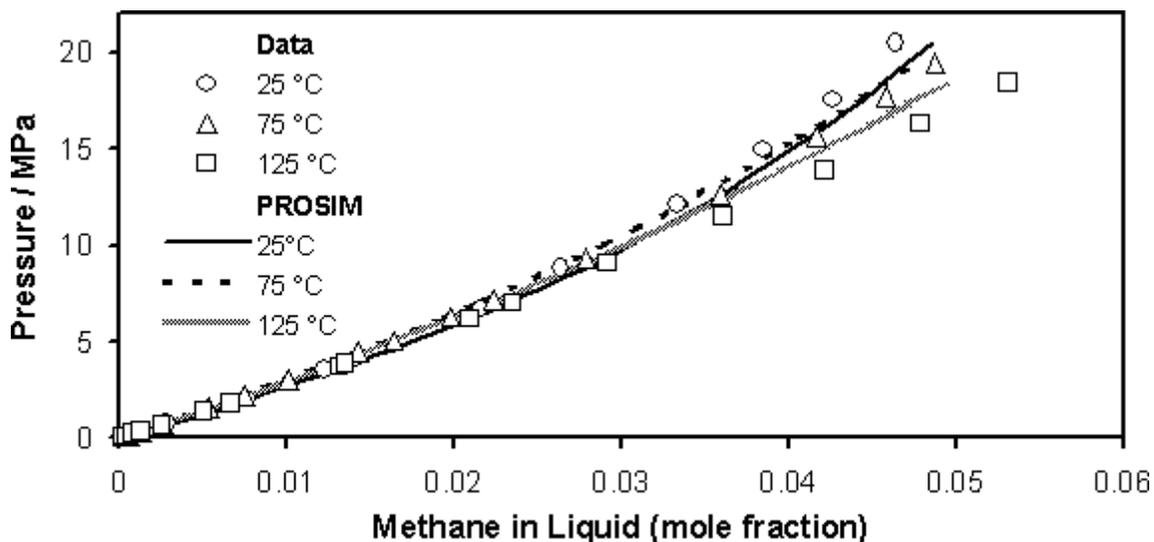
Data Source	T (°C)	P (MPa)	Feed Cmpt.	Feed Cmpt. (mol %)	Aqueous Liquid (mol %)	
					Data	PROSIM
RR-117	50	6.922	H2O	38.41	86.40	86.31
			EG	6.01	13.50	13.53
			Methane	33.35	0.147	0.154
			Methylcyclohexane	22.23	0.0015	0.0016
RR-117	50	6.950	H2O	20.37	59.30	59.16
			EG	13.79	40.20	40.18
			Methane	39.50	0.320	0.237
			Toluene	26.34	0.209	0.425
RR-149	10	6.919	H2O	55.33	77.35	77.36
			EG	16.06	22.46	22.46
			Methane	17.02	0.189	0.179
			Propane	2.19	0.0052	0.0053
			n-Heptane	9.40	0.00020	0.00025
RR-149	38	6.991	H2O	42.70	77.36	77.35
			EG	12.40	22.46	22.47
			Methane	20.72	0.172	0.172
			Propane	4.58	0.0086	0.0080
			Methylcyclohexane	19.60	0.0021	0.0020
RR-149	38	6.922	H2O	43.62	77.33	77.25
			EG	12.66	22.45	22.45
			Methane	18.77	0.170	0.174
			Propane	4.71	0.0108	0.0100
			Toluene	20.24	0.0382	0.1200
RR-137	50	2.096	EG	92.10	99.28	99.48
			Methane	7.50	0.302	0.105
			Benzene	0.149	0.154	0.152
			Toluene	0.126	0.132	0.131
			Ethylbenzene	0.0117	0.0123	0.0123
			o-Xylene	0.110	0.116	0.116
RR-137	25	6.922	H2O	38.12	45.97	46.02
			EG	44.36	53.50	53.58
			Methane	17.38	0.391	0.249
			Benzene	0.0548	0.0488	0.0539
			Toluene	0.0465	0.0428	0.0469
			Ethylbenzene	0.0043	0.0040	0.0043
			o-Xylene	0.0403	0.0409	0.0436

PROSIM matches the data very closely. The range of temperature and pressures was chosen because the conditions were similar to typical absorber conditions.

### **Diethylene Glycol**

Data by Jou et al [2] contain information on the solubility of methane in DEG. Comparisons of PROSIM to equilibrium data for methane at 25, 75, and 125°C are shown in Figure 1. Interestingly, the solubilities of methane,

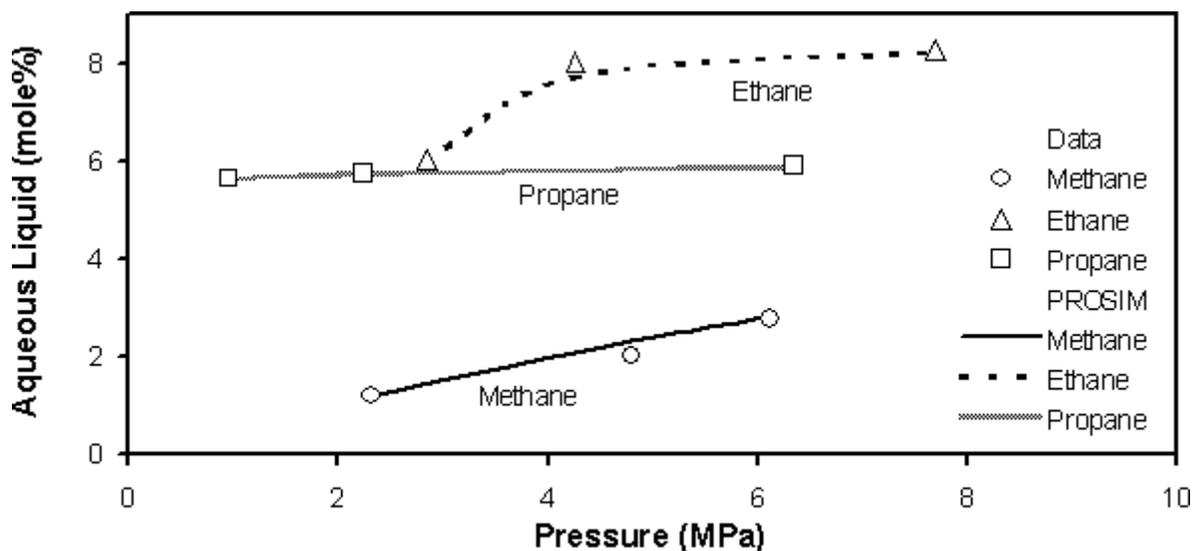
ethane, and propane in DEG [2] and EG [10] increase with temperature. PROSIM predicts this unexpected behavior accurately.



**Figure 1. Methane Solubility in Diethylene Glycol**

**Triethylene Glycol**

GPA RR-131 [11] and Jou et al. [12] contain equilibrium data for solubility of methane, ethane, propane, benzene, toluene, ethylbenzene, and o-xylene in TEG. PROSIM predictions are compared to selected data from these sources in Figure 2 and Table 2.



**Figure 2. Hydrocarbon Solubility in TEG**

**Table 2  
Hydrocarbon Solubility in TEG**

Data Source	T (°C)	P (MPa)	Feed Cmpt.	Feed Comp (mol %)	Aqueous Liquid (mol %)	
					Data	PROSIM
RR-131	25	2.068	TEG	85.76	97.90	97.92
			Methane	13.38	1.11	1.09
			Benzene	0.33	0.373	0.371
			Toluene	0.28	0.314	0.313
			Ethylbenzene	0.02	0.0279	0.0274
			o-Xylene	0.24	0.279	0.278
RR-131	50	2.068	TEG	86.75	97.86	97.93
			Methane	12.37	1.13	1.08
			Benzene	0.33	0.373	0.368
			Toluene	0.28	0.314	0.312
			Ethylbenzene	0.03	0.0279	0.0281
			o-Xylene	0.25	0.279	0.278
RR-131	25	6.895	TEG	63.22	95.86	95.87
			Methane	36.14	3.17	3.16
			Benzene	0.24	0.365	0.360
			Toluene	0.20	0.308	0.305
			Ethylbenzene	0.02	0.030	0.027
			o-Xylene	0.18	0.273	0.272
RR-131	50	6.895	TEG	65.92	95.78	95.82
			Methane	33.42	3.25	3.23
			Benzene	0.25	0.365	0.356
			Toluene	0.21	0.307	0.303
			Ethylbenzene	0.02	0.027	0.027
			o-Xylene	0.19	0.273	0.271

PROSIM matches the data closely.

### ***Methanol***

GPA RR-117 [7] and RR-149 [8] contain equilibrium data for solubility of methane, propane, n-heptane, methylcyclohexane, and toluene in methanol. A comparison of hydrocarbon solubility as predicted by PROSIM to selected equilibrium data is shown in Table 3.

**Table 3**  
**Hydrocarbon Solubility in Methanol**

Data Source	T (°C)	P (MPa)	Feed Cmpt	Feed Comp (mol %)	Aqueous Liquid (mol %)	
					Data	PROSIM
RR-117	20	6.915	H2O	19.00	43.05	42.79
			Methanol	24.95	55.45	55.53
			Methane	33.63	1.39	1.24
			n-Heptane	22.42	0.115	0.435
RR-117	20	7.936	H2O	18.33	42.81	42.60
			Methanol	24.09	55.30	55.20
			Methane	34.55	1.62	1.46
			Methylcyclohexane	23.03	0.226	0.766

**Table 3**  
**Hydrocarbon Solubility in Methanol (continued)**

Data Source	T (°C)	P (MPa)	Feed Cmpt	Feed Comp (mol %)	Aqueous Liquid (mol %)	
					Data	PROSIM
RR-117	50	7.019	H2O	39.88	76.94	77.00
			Methanol	12.10	22.74	22.80
			Methane	28.81	0.312	0.260
			Methylcyclohexane	19.21	0.0071	0.0086
RR-117	50	8.032	H2O	38.23	77.58	77.60
			Methanol	11.59	21.95	22.00
			Methane	30.11	0.371	0.295
			Toluene	20.07	0.104	0.151
RR-149	38	6.895	H2O	70.02	84.02	84.06
			Methanol	13.13	15.75	15.73
			Methane	15.16	0.203	0.179
			Propane	1.69	0.0192	0.0260
RR-149	38	6.936	H2O	62.87	84.04	84.03
			Methanol	11.86	15.76	15.77
			Methane	13.25	0.195	0.189
			Propane	2.26	0.0076	0.0113
			n-Heptane	9.76	0.0005	0.0005
RR-149	11	6.922	H2O	61.42	83.98	84.02
			Methanol	11.54	15.74	15.74
			Methane	15.43	0.267	0.221
			Propane	2.22	0.0064	0.0133
			Methylcyclohexane	9.38	0.0013	0.0023
RR-149	38	6.922	H2O	62.21	84.00	84.03
			Methanol	11.88	15.75	15.71
			Methane	10.51	0.188	0.190
			Propane	2.88	0.0112	0.0150
			Toluene	12.52	0.0489	0.0580
RR-149	-4	6.936	H2O	48.44	63.59	63.59
			Methanol	27.24	35.78	35.75
			Methane	21.88	0.530	0.437
			Propane	2.43	0.112	0.221
RR-149	38	6.895	H2O	45.09	63.61	63.84
			Methanol	25.36	35.78	35.66
			Methane	17.57	0.553	0.436
			Propane	2.26	0.043	0.052
			n-Heptane	9.72	0.017	0.016
RR-149	-4	6.922	H2O	41.91	63.62	63.72
			Methanol	23.57	35.78	35.74
			Methane	19.85	0.554	0.456
			Propane	2.78	0.0315	0.0570
			Methylcyclohexane	11.89	0.0169	0.0320
RR-149	38	6.895	H2O	43.52	63.39	63.88
			Methanol	24.48	35.65	35.00
			Methane	16.73	0.553	0.488
			Propane	2.89	0.072	0.082
			Toluene	12.38	0.335	0.547

There is good agreement between PROSIM predictions and the equilibrium data. PROSIM predicts somewhat

higher methylcyclohexane solubility than the data shows.

### **DEPG**

The hydrocarbon solubility in DEPG for PROSIM was fitted using data from the literature as well as other data. The overall fit of the data was quite good, however, the comparison to the limited literature data presented in Table 4 showed that PROSIM overpredicted the hydrocarbon solubility by about 15%.

**Table 4**  
**Hydrocarbon Solubility in DEPG**

Component	H (kPa/mole fraction)	H (kPa/mole fraction)
	Data	PROSIM
Propane	2142 - 2176	1815
n-Butane	719 - 727	581

## **APPLICATIONS FOR PHYSICAL SOLVENTS**

The following sections contain examples of typical uses of physical solvents for which hydrocarbon absorption is a concern. Based on data available in the literature for operating units, several plants are used to demonstrate methods of minimizing or maximizing hydrocarbon absorption by the physical solvents.

### **Dehydration Using Glycols**

The most commonly used glycols for dehydration applications are EG, DEG, and TEG, with TEG being the most popular due to ease of regeneration and low solvent losses. Unfortunately, TEG absorbs significantly more hydrocarbons than DEG or EG as suggested by the solubility data in Table 5 [15].

**Table 5**  
**Solubility of Benzene and Toluene in Glycols**

Compound	Solubility (weight % at 25°C)		
	EG	DEG	TEG
Benzene	5.7	31.3	Completely Soluble
Toluene	2.9	17.2	24.8

More stringent emissions regulations have forced the use of some methods of minimizing hydrocarbon pickup or disposing of the emissions in glycol dehydration units. In the USA, emissions are limited to 25 tons per year with not more than 10 tpy of any one pollutant.

Some methods for minimizing hydrocarbon absorption are as follows:

1. Decrease the glycol circulation rate.
2. Decrease the absorber pressure.
3. Select a glycol that absorbs the least amount of BTEX or hydrocarbon if possible.

Once absorbed, some method of dealing with emissions must be implemented. Regenerator vent gases must be incinerated or partially condensed with hydrocarbon recovery, or the rich flash heated to maximize flash gas hydrocarbon content. However, this flash gas must be incinerated as well. A BTEX stripper may be used in the

rich glycol to reduce emissions [16]. The gas from the stripper can be used as reboiler or other fuel. The best method of reducing hydrocarbon pickup is to limit the absorption initially by implementing the items above if possible. It may not be feasible, however, to decrease the absorber pressure, as the cost of recompression may be prohibitive. Likewise with temperature, heating the feed gas might not be an option. EG or DEG can be used instead of TEG to significantly reduce the emissions, provided the water content specification for the dry gas can be achieved. It has been shown that using EG instead of TEG can result in greater than 70% reduction in hydrocarbon absorption [16].

The TEG dehydration unit described by Ebeling et al [16] contained a BTEX stripper to remove BTEX compounds from the dehydration unit containing the following BTEX feed composition and operating conditions.

**Table 6**  
**Operating Conditions and BTEX Feed Composition for Glycol Dehydration Unit**

Parameter	Value
Wet Gas Flow Rate	29.2 MMSCFD
Wet Gas Temperature	69°F
Contactor Pressure	305 psia
Glycol Circulation Rate	2.34 gpm
Lean Glycol Temperature	133°F
Benzene in Inlet	0.0005 mole %
Toluene in Inlet	0.0007 mole %
Ethylbenzene in Inlet	< 0.0001
Xylenes in Inlet	<0.0001

Using those same parameters in a dehydration unit without the BTEX stripper as shown in Figure 3, PROSIM was used to calculate the emissions from the stripper for EG, DEG, and TEG at three circulation rates as shown in Figure 4. This figure shows a significant decrease in BTEX and other emissions by using lower circulation rates for the same glycol. An even greater decrease in emissions can be achieved by using a glycol that absorbs less hydrocarbon. In this example, the VOC emissions must not exceed 25 tons/year. EG meets the specification easily. DEG also meets the specification, however, the emissions approach the 25 tons/yr limit at 4 gal/lb. TEG exceeds the specification limit at 2.5 gal/lb resulting in the need for some type of emission recovery unit at higher rates. Available processes include the BTEX stripper previously mentioned, incineration of stripper off-gas, or partial condensation and recovery of BTEX from the stripper overhead.

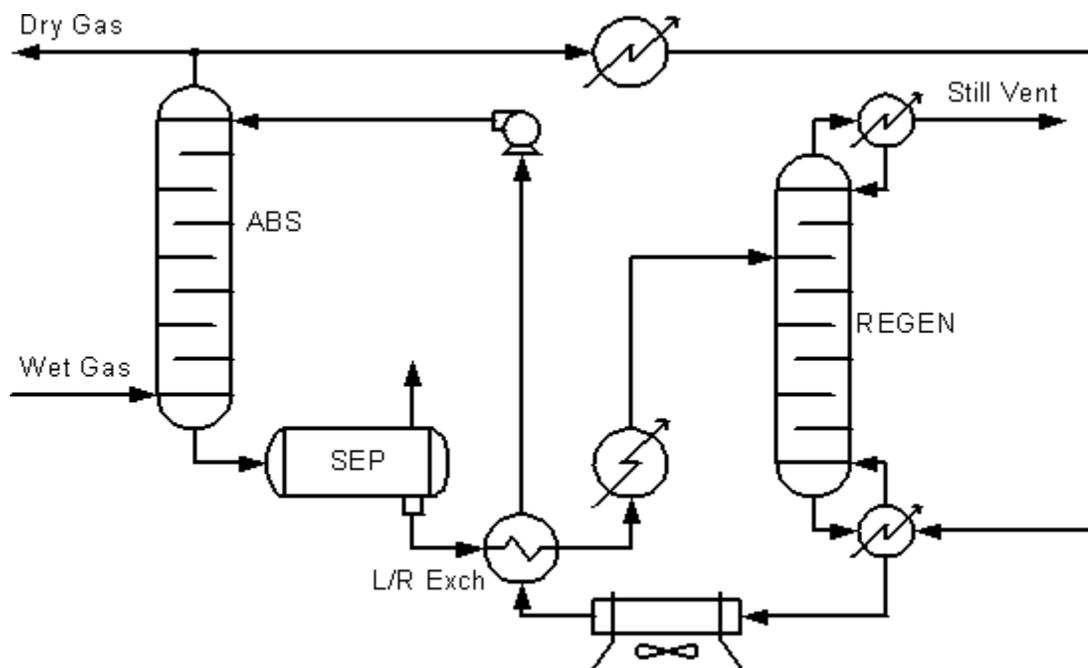


Figure 3. TEG Dehydration Unit

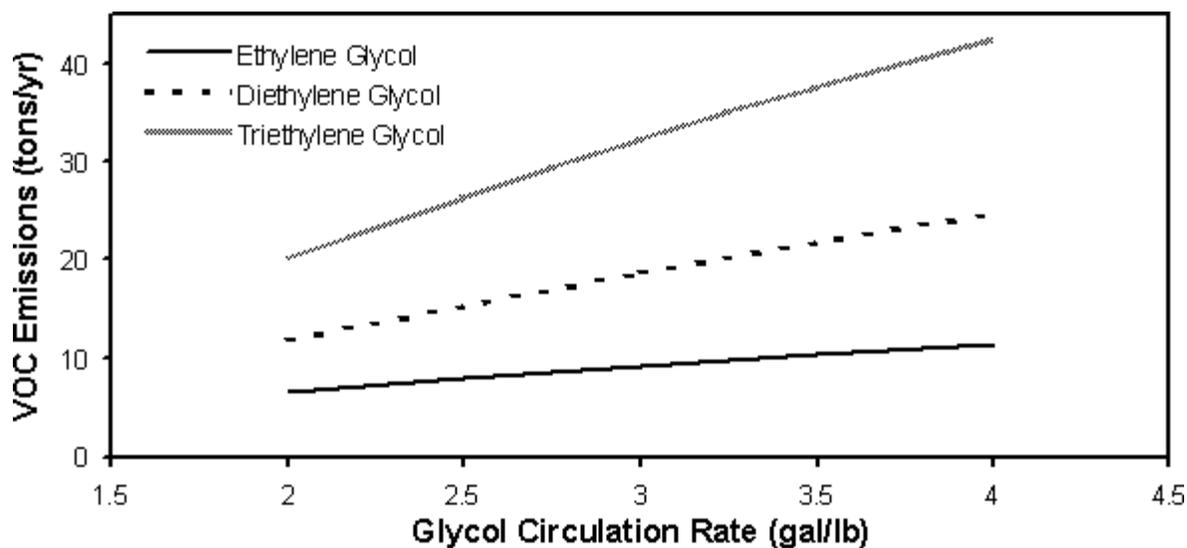


Figure 4. Emissions Comparison from Glycol Dehydration Unit

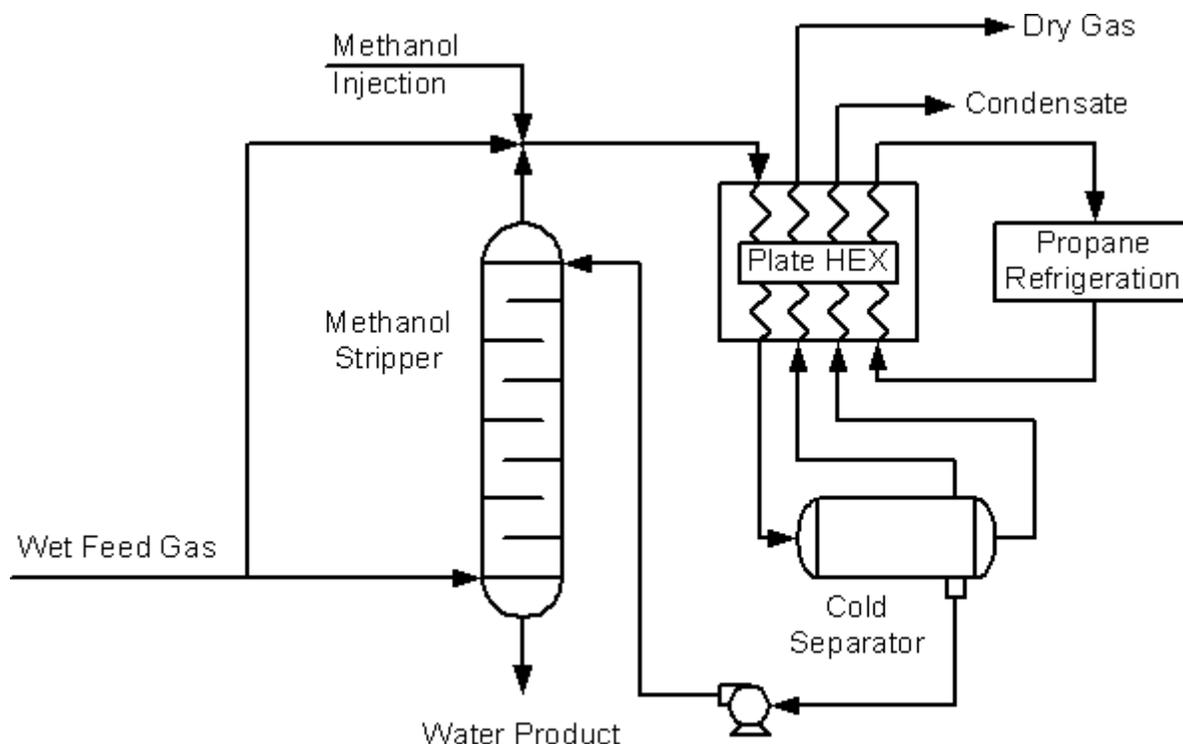
### Dehydration Using Methanol

Methanol has been successfully used for dehydration for many years, and may also be used for acid gas removal (to be discussed in a later section). Currently this dehydration technology is most commonly available as the Ifpexol<sup>®</sup> process [17] which can accomplish both water and hydrocarbon removal. Figure 5 shows a typical Ifpex-1 flow scheme as described by Minkinen and Jonchere [18]. The Ifpex-1 process involves stripping methanol from the methanol-water stream exiting the cold separator using wet inlet gas. The methanol stripped from the methanol-water stream is in effect injected into the wet gas with additional methanol to prevent freezing in the cold separator. An almost pure water stream exits the bottom of the methanol stripper. After cooling of the gas, the liquid hydrocarbon phase and aqueous phases are separated in a cold separator. Because no heat stripping of the methanol is required and the methanol from the cold separator is recycled to the process gas stream,

hydrocarbon losses would be limited to their solubility in the water stream which is quite low.

### ***EG or Methanol Injection***

EG and methanol are commonly injected into gas streams to inhibit hydrate formation. After chilling and separation from the hydrocarbon phases, the aqueous EG or methanol phase is usually stored in atmospheric pressure tanks for disposal. Since the atmospheric storage tanks are below the separator pressure, hydrocarbons absorbed by the injected EG or methanol may flash. Since the separator temperature and pressure are usually fixed, the best method of minimizing the amount of hydrocarbon in the aqueous phase is to avoid over-injecting the hydrate inhibitor. If the EG is to be regenerated, the stripper off-gas must be processed as described in the preceding glycol dehydration section.



**Figure 5. Ifpex-1 Process**

### ***Removal of Acid Gas and Other Impurities Using DEPG***

Solvents containing DEPG are licensed and/or manufactured by several companies including Coastal Chemical (as Coastal AGR), Union Carbide, and UOP. This physical solvent has a wide range of applications and although it has some dehydrating capability, it is more commonly used in acid gas treating. It is also used in hydrocarbon removal to achieve a hydrocarbon dew point which will be discussed in a later section [3]. In fact, all three objectives—dehydration, acid gas removal, and hydrocarbon recovery—can all be accomplished to an extent in the same unit [1]. DEPG was originally used to remove impurities from ammonia synthesis gas and was the choice for fertilizer plant applications [19]. Because of the hydrocarbon absorption in DEPG, it was not used for natural gas treating until later and even then was not used with rich gas streams [20]. DEPG is typically used for high pressure (>500 psia) applications. At higher pressures, the solubilities of  $H_2S$ ,  $CO_2$ , and other contaminants is higher, and the feed gas is at a sufficiently high pressure for subsequent solvent pressure let-down in a series of flashes involved in regeneration. Air stripping, vacuum flashing, and occasionally reboiling or steam stripping are also used if a very lean solvent is required to meet the sweet gas specifications.

Temperature, pressure, solvent water concentration, and solvent circulation rate all affect hydrocarbon co-absorption. Obviously, the circulation rate should be minimized to minimize hydrocarbon absorption. By

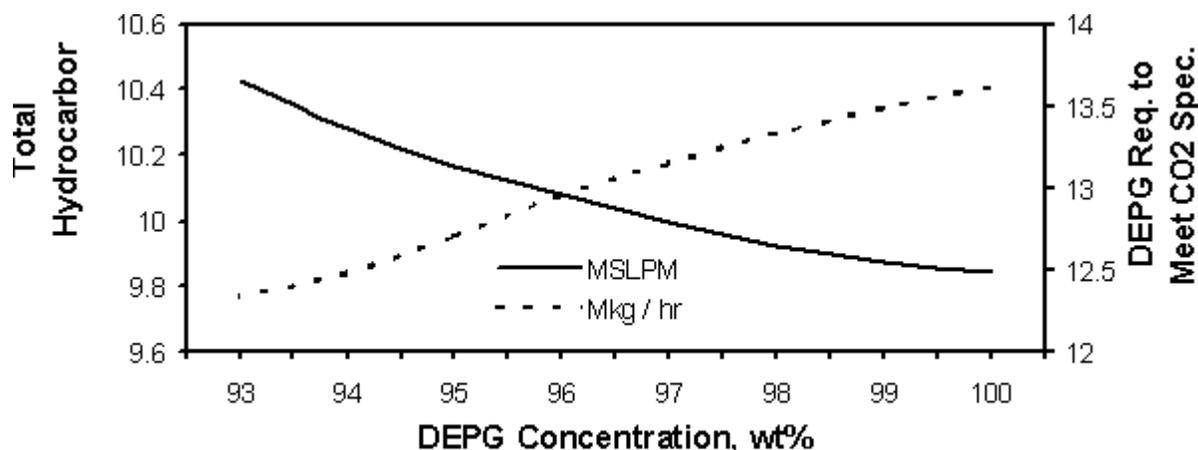
increasing the water content of the solvent, less hydrocarbons are absorbed [3]. The following plant demonstrates the hydrocarbon absorption changes with the water content of the solvent. It was found that temperature and pressure had a minimal effect on the hydrocarbon absorption in this particular case.

The plant inlet feed composition and conditions listed in Table 7 were used for this case to examine the influence of water on the hydrocarbon solubility in DEPG.

**Table 7**  
**Inlet Feed Composition and Conditions for DEPG Acid Gas Removal Unit**

	<b>Data</b>	<b>PROSIM</b>
Lean DEPG Conc. (weight %)	93.44	93.44
Inlet Gas Flow (KSCMD)	4600	4600
Inlet CO <sub>2</sub> (mole %)	30.3	30.3
Inlet Pressure (kPa)	6136	6136
Inlet Temperature (°C)	15.56	15.56
Outlet CO <sub>2</sub> (mole %)	2.99	3.04
Outlet N <sub>2</sub> (mole %)	0.63	0.62
Outlet C <sub>1</sub> (mole %)	95.35	95.30
Outlet C <sub>2</sub> (mole %)	1.00	0.93
Outlet C <sub>3</sub> (mole %)	0.00	0.07
Lean CO <sub>2</sub> Loading (mol/mol)	0.03	0.03
Lean DEPG Temperature (°C)	-13.9	-13.9

The absorber was modeled as a stand alone absorber with a constant lean CO<sub>2</sub> loading of 0.03. The circulation rate was adjusted to meet the 3 mole% CO<sub>2</sub> specification in the sweet gas. As shown in Figure 6, the required circulation rate increases as the DEPG concentration decreases. However, as also shown in Figure 6, even though a higher circulation rate is required to meet the CO<sub>2</sub> specification at lower DEPG concentrations, the total hydrocarbon absorption is lower due to the increasing influence of water. In this case the circulation rate is increased by 9.4% while the total hydrocarbon absorption decreases.



**Figure 6. Effect of Increasing Water Content in DEPG**

### ***Acid Gas Removal Using Methanol***

Methanol has been used in a number of applications for sweetening streams containing CO<sub>2</sub> and H<sub>2</sub>S. Some processes using methanol as a sweetening solvent are Rectisol [19] and the Ispex-2 process [18]. Methanol is normally used for selective cases and for bulk CO<sub>2</sub> removal. The hydrocarbon co-absorption may be manipulated by adjusting the water content of the solvent [4] in a manner similar to that described for DEPG. The higher the

water content, the lower the hydrocarbon solubility in the solvent. Increasing the concentration of water in the circulating solvent, however, reduces the acid gas absorption capacity. The optimum methanol concentration which minimizes hydrocarbon pickup while allowing the sweet gas specification to be met at a reasonable circulation rate must be determined. For larger units there are proprietary additions to Iplex-2 which can recover hydrocarbons [4].

The following analysis is based on plant data from Staton et al [21] for a pilot plant using methanol for sweetening a crude coal gas. This plant is similar to the flow scheme for an Iplex-2 unit and is less complicated than a Rectisol unit. The flow diagram is shown in Figure 7. Table 8 lists the operating data.

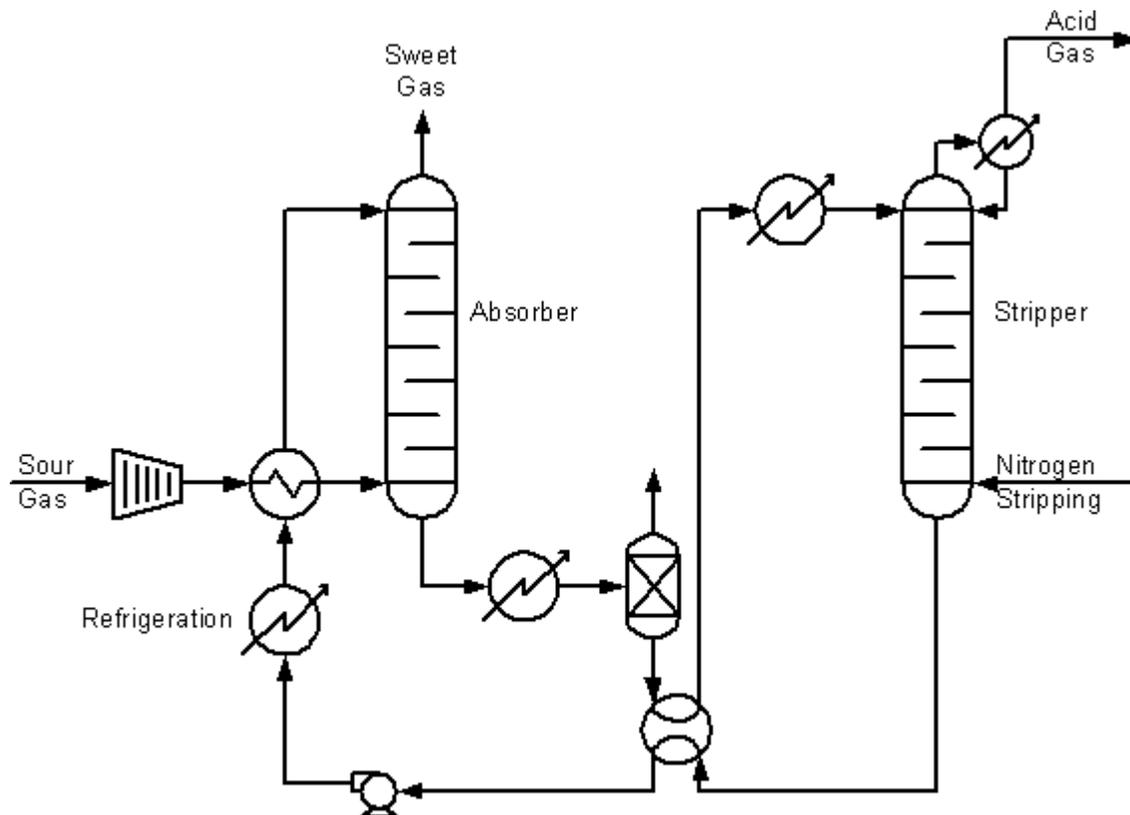


Figure 7. Methanol Sweetening Unit

Table 8  
Acid Gas Sweetening with Methanol Example

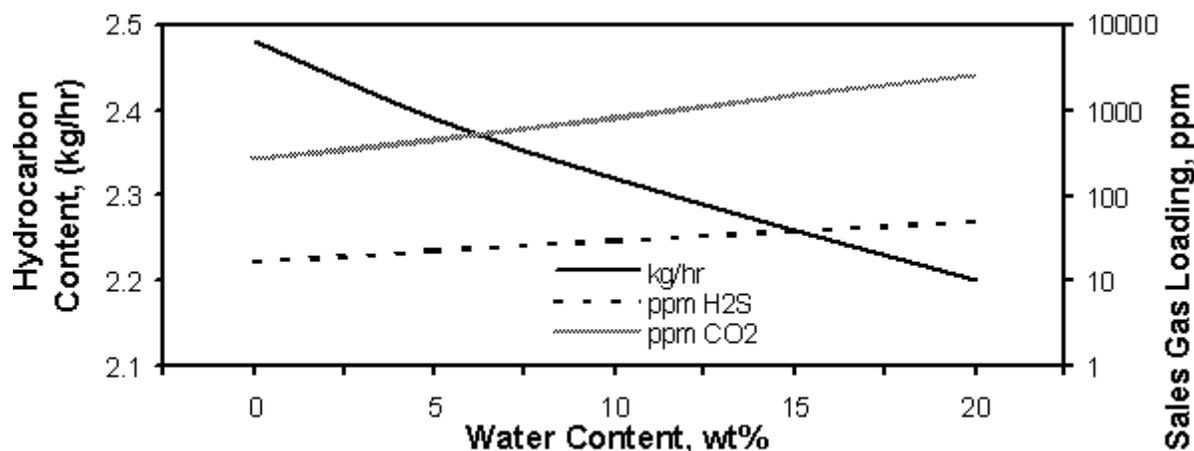
Parameter	Data	PROSIM
Methanol Circ. Rate (lpm)	4.8	4.8
Inlet Gas Rate (SCMD)	576	576
Inlet Pressure (kPa)	3191	3191
Gas Inlet Temp (°C)	17.0	17.0
Methanol Inlet Temp (°C)	-33.3	-33.3
Flash Pressure (kPa)	613	613
Inlet CO <sub>2</sub> (mole %)	27.51	27.51
Inlet H <sub>2</sub> S (mole %)	0.3042	0.3042
Outlet CO <sub>2</sub> (ppm)	--	272
Outlet H <sub>2</sub> S (ppm)	16	17
HC in Rich Methanol (kg/hr)	--	2.48

Table 9 shows a comparison of the hydrocarbon content in the feed, flash gas, and acid gas as compared to PROSIM predictions.

**Table 9**  
**Hydrocarbon Content of Methanol Sweetening Plant Streams**

Component	Hydrocarbon Content (mole %)					
	Sour Feed	Flash Gas		Acid Gas		
	Data	Data	PROSIM	Data	PROSIM	
Methane	5.35	13.54	16.07	3.03	1.98	
Ethylene	0.2971	0.6660	0.9225	0.4506	0.4274	
Ethane	0.4241	0.9971	0.9132	0.6573	0.7166	
Propylene	0.1290	0.0710	0.1055	0.2264	0.2463	
Propane	0.0530	0.0411	0.0380	0.0913	0.1020	
Butylene	0.0550	0.0128	0.0130	0.1011	0.1094	
Butane	0.0167	0.0048	0.0036	0.0291	0.0332	
Benzene	0.0371	0.0012	0.0013	0.0572	0.0776	
Toluene	0.0110	0.0001	0.0003	0.0060	0.0218	
Ethylbenzene	0.0008	0	0	0	0.00097	
p-Xylene	0.0004	0	0	0	0.00044	
m-Xylene	0.0018	0	0	0.0003	0.0023	
o-Xylene	0.0009	0	0	0	0.0010	

An analysis was made to examine the influence of water content in the methanol on the hydrocarbon absorption. The results as presented in Figure 8 show that increasing the water content from 0 wt% to 20 wt% decreases the hydrocarbon pickup by 11%. This decrease in hydrocarbon absorption is much smaller than would be expected from other solvents with a 20% increase in water. This is due to the highly polar nature of methanol compared to the other solvents. The increased water also decreased the CO<sub>2</sub> and H<sub>2</sub>S absorption, as expected. The HC content in Table 10 is taken from the rich methanol stream exiting the bottom of the absorber.



**Figure 8. Effect of Increasing the Water Content in Methanol**

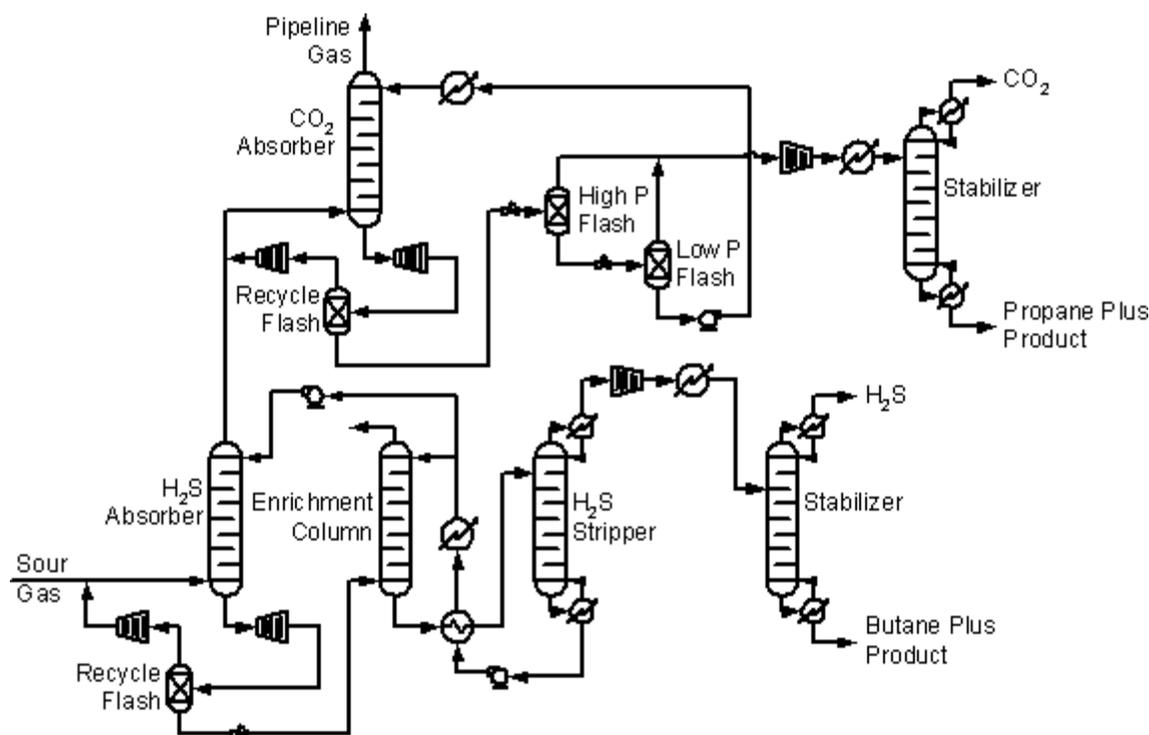
The effect of temperature was also studied, but the benefits were not significant. The hydrocarbon content of the rich methanol at  $-40^{\circ}\text{C}$  was 2.51 kg/hr as compared to 2.38 kg/hr at  $0^{\circ}\text{C}$ , which is a 5% decrease. With methanol systems it is advantageous to operate at colder temperatures to avoid solvent losses [22].

#### **Hydrocarbon Dew Point Control**

DEPG has been used to remove hydrocarbons from a natural gas stream in a process similar to a lean oil absorption unit. This process is described by Shah [1]. In the integrated process, water, acid gas, and

hydrocarbon product are all removed in the same unit to meet water, H<sub>2</sub>S, CO<sub>2</sub>, and hydrocarbon dew point specifications. The basic flow scheme is shown in Figure 9. As with other applications of DEPG, lower temperature and higher pressure result in more hydrocarbon and acid gas pickup. Since hydrocarbon absorption is desirable in this case, the lower temperature enhances absorption of hydrocarbons, CO<sub>2</sub>, H<sub>2</sub>S and other impurities and allows the circulation rate to be minimized. The benefits of using DEPG for hydrocarbon recovery over a lean oil unit are:

1. Ambient instead of high temperature regeneration.
2. Regeneration of rich solvent accomplished by flashing instead of heating, which reduces the energy requirement.
3. No reclaiming.



**Figure 9. Selexol ITR Process**

**SUMMARY**

As shown in the preceding sections, hydrocarbons are soluble in physical solvents and the solubility can be minimized or maximized to assist in meeting objectives. The operating recommendations for each of the physical solvents discussed here can be summarized as follows:

**Recommendations for Physical Solvents**

Solvent	Application	Recommendations
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EG	Dehydration	* Minimize circulation rate to minimize HC absorption * HC solubility decreases with decreasing temperature
EG DEG	Injection Dehydration	* Minimal hydrocarbon absorption compared to other glycols * Minimize injection rate * Less HC pickup than TEG
TEG	Dehydration	* Minimize circulation rate to minimize HC absorption * Minimize circulation rate to minimize HC absorption
MeOH	Dehydration	* Use DEG or EG if possible to reduce emissions * Low emissions
MeOH MeOH	Injection Sweetening	* Hydrocarbons are recovered simultaneously * Solvent is usually discarded, but minimize amount injected * Optimize water content of solvent (the higher the water content, the lower the HC absorption; circulation rate must increase due to lower acid gas absorption)
DEPG	Sweetening	* Solvent temperature must be very low to minimize losses * Optimize water content
DEPG	HC Dew Point Control	* Pressure should be high to facilitate regeneration by flashing * Maximize HC absorption  * Accomplishes sweetening, HC dew point control, and water dew point all in one unit  * Similar to lean oil plant

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